

#2

PTO/SB/64/PCT (10-00)

Approved for use through 10/31/2002. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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**PETITION FOR REVIVAL OF AN INTERNATIONAL APPLICATION FOR PATENT
DESIGNATING THE U.S. ABANDONED UNINTENTIONALLY UNDER 37 CFR 1.137(b)**

Docket Number (Optional)
03-L0-6740

First named inventor: Kamron M. Wright
International (PCT) Application No.: PCT/US99/14753 U.S. Application No.: Unassigned
Filed: 29 JUN 1999 (if known)
Title: MOTOR ENDSHIELD ASSEMBLY FOR AN ELECTRONICALLY COMMUTATED MOTOR

REC

01

Attention: PCT Legal Staff
Box PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Legal Staff
International Division

The above-identified application became abandoned as to the United States because the fees and documents required by 35 U.S.C. 371(c) were not filed prior to the expiration of the time set in 37 CFR 1.494(b) or (c) or 1.495(b) or (c) as applicable. The date of abandonment is the day after the date on which the 35 U.S.C. 371(c) requirements were due. See 37 CFR 1.494(g) or 1.495(h).

RECEIVED

01 MAY 2001

Legal Staff
International Division

APPLICANT HEREBY PETITIONS FOR REVIVAL OF THIS APPLICATION

NOTE: A grantable petition requires the following items:

- (1) Petition fee
- (2) Proper reply
- (3) Terminal disclaimer with disclaimer fee--required for all international applications having an international filing date before June 8, 1995; and
- (4) Statement that the entire delay was unintentional.

1. Petition fee

- ☐ Small entity - fee \$ _____ (37 CFR 1.17(m)). Applicant claims small entity status. See 37 CFR 1.27.
- ☒ Other than small entity - fee \$ 1,240 (37 CFR 1.17(m))

2. Proper reply

- A. The proper reply (the missing 35 U.S.C. 371(c) requirement(s) in the form of Transmittal Letter to the United States Designated/Elected Office (DO/E0/US) (identify type of reply):
Concerning a Filing Under 35 USC 371
 - ☐ has been filed previously on _____
 - ☒ is enclosed herewith.

04/05/2001 MNGUYEN 00000107 012384 09806604
03 FC:141 1240.00 CH

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

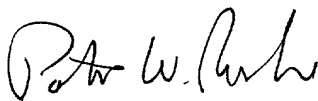
3. Terminal disclaimer with disclaimer fee

- ☒ Since this international application has an international filing date on or after June 8, 1995, no terminal disclaimer is required.
- ☐ A terminal disclaimer (and disclaimer fee (37 CFR 1.20(d)) of \$_____ for a small entity or \$_____ for other than a small entity) disclaiming the required period of time is enclosed herewith (see PTO/SB/63).

4. Statement. The entire delay in filing the required reply from the due date for the required reply until the filing of a grantable petition under 37 CFR 1.137(b) was unintentional.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

02 April 2001
Date



Signature

Patrick W. Rasche

Typed or printed name

Armstrong Teasdale LLP

Address

One Metropolitan Square, Suite 2600

St. Louis, MO 63102

Enclosures: ☒ Response
☒ Fee Payment
☐ Terminal Disclaimer Form
☒ Certificate of Express Mail

FORM-PTO-1390
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

03-L0-6740

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/806604

INTERNATIONAL APPLICATION NO.

PCT/US99/14753

INTERNATIONAL FILING DATE

29 JUN 1999

PRIORITY DATE CLAIMED

30 JUN 1998

TITLE OF INVENTION

MOTOR ENDSHIELD ASSEMBLY FOR AN ELECTRONICALLY COMMUTATED MOTOR

APPLICANT(S) FOR DO/EO/US

Kamron M. WRIGHT; Peter B. LYTLE; Andrew N. YOUNG

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☒ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: Certificate Of Express Mail
Petition to Revoke

U.S. APPLICATION NO. (if known, see 37 CFR 1.53)

097/806604

INTERNATIONAL APPLICATION NO
PCT/US99/14753ATTORNEY'S DOCKET NUMBER
03-L0-674021. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO. \$1000.00International preliminary examination fee (37 CFR 1.482) not paid to
USPTO but International Search Report prepared by the EPO or JPO \$860.00International preliminary examination fee (37 CFR 1.482) not paid to USPTO
but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00International preliminary examination fee (37 CFR 1.482) paid to USPTO
but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00International preliminary examination fee (37 CFR 1.482) paid to USPTO
and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00**ENTER APPROPRIATE BASIC FEE AMOUNT =****CALCULATIONS PTO USE ONLY**

\$ 690.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	25 - 20 =	5	x \$18.00	\$ 90.00
Independent claims	3 - 3 =	0	x \$80.00	\$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00	\$
TOTAL OF ABOVE CALCULATIONS =				\$ 780.00

\$

\$ 90.00

\$

\$

\$ 780.00

☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above
are reduced by 1/2.

\$

SUBTOTAL =

\$ 780.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(f)).

\$

TOTAL NATIONAL FEE =

\$ 780.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be
accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$

TOTAL FEES ENCLOSED =

\$ 780.00

Amount to be
refunded:

\$

charged:

\$

a. ☐ A check in the amount of \$ _____ to cover the above fees is enclosed.b. ☒ Please charge my Deposit Account No. 01-2384 in the amount of \$ 780.00 to cover the above fees.
A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
overpayment to Deposit Account No. 01-2384. A duplicate copy of this sheet is enclosed.d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card**
information should not be included on this form. Provide credit card information and authorization on PTO-2038.**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR
1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

John S. Beulick
Armstrong Teasdale, LLP
One Metropolitan Square, Suite 2600
St. Louis, MO 63102

SIGNATURE

Patrick W. Rasche

NAME

37,916

REGISTRATION NUMBER

Express Mail Label No. EL319729823US

03LO6740

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re International Application of: :
General Electric Company :
 :
International Application No. :
PCT/US99/14753 : Authorized Officer: Clayton Laballe
 :
International Filing Date: 29 JUN 1999 :
 :
For: MOTOR ENDSHIELD :
ASSEMBLY FOR AN :
ELECTRONICALLY :
COMMUTATED MOTOR :

AMENDMENT IN RESPONSE TO WRITTEN OPINION
(PCT Rule 66)

Assistant Commissioner for Patents
Box PCT
Attn. RO/US
Washington, D.C. 20231

Sir:

The International Preliminary Examining Authority Written Opinion mailed 17 MAY 2000 has been carefully reviewed and the following amendments and remarks are submitted in consequence thereof.

Amendments

Please substitute replacement sheets 8, 9 and 10 for previously filed sheets 8, 9 and 10.

Remarks

The replacement sheets differ from the replaced sheets in that claims 4, 9, and 16 are replaced by amended Claims 4, 9, and 16. Claim 4 has been amended to depend from Claim 3. Claim 9 was amended to correct the improper antecedent basis for "thermal pad". Claim 16

was amended to change the order of the elements of the claimed structure to provide proper antecedent basis.

The statement as to novelty was positive with respect to Claims 2, 4, 6 - 14 and 16 - 25 and negative with respect to Claims 1, 3, 5 and 15. The statement as to inventive step was positive with respect to none and negative with respect to Claims 1 - 25. The statement as to Industrial Applicability was positive with respect to Claims 1 - 25 and negative with respect to none.

The statement that Claims 1, 3, 5 and 15 lack novelty under PCT Article 33(2) as being anticipated by Harms et al. is respectfully traversed.

Harms et al. describe an electronically commutated motor. More specifically, as described at Col. 9, lines 46 - 53, in Harms et al., the motor comprises "a flat faced end shield or adapter 73, having a plurality of rabbit-ear extensions 74 thereon is mounted to housing 71 at one opposite end thereof and a thermally conductive enclosure or enclosure means, such as a housing 75 or the like for instance, is arranged in mounting and enclosing association with the flat faced end shield thereby to enclose the housing at the one opposite end thereof."

Applicants respectfully submit that Harms et al. do not describe the presently claimed invention. Specifically, Claim 1 recites a motor endshield assembly comprising "an endshield comprising an outer surface and an inner surface", "a control assembly in contact with said inner surface; and a power assembly connected to said control assembly." Harms et al. do not describe such an assembly. Rather, Harms et al. describe attaching an enclosure to an endshield, best shown in Figure 6, where the separate enclosure contains the electronics associated with an electronically commutated motor and the enclosure also performs the heat sinking function. The Harms et al. electronically commutated motor does not describe an endshield assembly to which the power and control electronics can be attached and which also perform the heat sinking function. Applicants respectfully submit that Claim 1 meets the criteria for novelty and inventive step over Harms et al.

Claims 3, 5 and 15 depend directly from independent Claim 1. When the recitations of dependent Claims 3, 5 and 15 are considered in combination with the recitations of independent Claim 1, Applicants respectfully submit that Claims 3, 5 and 15 likewise meet the criteria for novelty and inventive step over Harms et al.

For the reasons set forth above, Applicants respectfully request that the statement that Claims 1, 3, 5 and 15 lack novelty under PCT Article 33(2) over Harms et al. be withdrawn.

The statement that Claims 11 and 12 lack inventive step under PCT Article 33(3) as being obvious over Harms et al. is respectfully traversed.

Harms et al. describe an electronically commutated motor. More specifically, as described at Col. 9, lines 46 - 53, in Harms et al., the motor comprises "a flat faced end shield or adapter 73, having a plurality of rabbit-ear extensions 74 thereon is mounted to housing 71 at one opposite end thereof and a thermally conductive enclosure or enclosure means, such as a housing 75 or the like for instance, is arranged in mounting and enclosing association with the flat faced end shield thereby to enclose the housing at the one opposite end thereof."

Specifically, Claims 11 and 12 depend directly from independent Claim 1. Specifically, Claim 1 recites a motor endshield assembly comprising "an endshield comprising an outer surface and an inner surface", "a control assembly in contact with said inner surface; and a power assembly connected to said control assembly." No such endshield assembly is taught or suggested by the cited reference. For at least the reasons set forth above with respect to the patentability of independent Claim 1, when the recitations of dependent Claims 11 and 12 are considered in combination with the recitations of independent Claim 1, Applicants respectfully submit that Claims 11 and 12 likewise meet the criteria for inventive step over Harms et al.

For the reasons set forth above, Applicants respectfully request that the statement that Claims 11 and 12 lack inventive step under PCT Article 33(3) over Harms et al. be withdrawn.

The statement that Claims 2, 4, 6 - 10, 13, 14, 16, 17, 19 and 21 - 25 lack inventive step under PCT Article 33(3) as being obvious over Harms et al. in view of Johnson et al. is respectfully traversed.

Harms et al. describe an electronically commutated motor. More specifically, as described at Col. 9, lines 46 - 53, in Harms et al., the motor comprises "a flat faced end shield or adapter 73, having a plurality of rabbit-ear extensions 74 thereon is mounted to housing 71 at one opposite end thereof and a thermally conductive enclosure or enclosure means, such as a housing 75 or the like for instance, is arranged in mounting and enclosing association with the flat faced end shield thereby to enclose the housing at the one opposite end thereof."

Johnson et al describe the use of potting material to support the portion of a circuit board that is distant from the portion of the circuit board supported by attaching an electronic component(s) to a heat sink. More specifically, as described at Col. 1, lines 62 - 67 and Col. 2, lines 1 - 3, in Johnson et al., "(a) housing receiving and supporting the printed wire board and heat sink. The heat sink is mounted on the housing and the printed wire board is mounted on the heat sink and extends outwardly from the heat sink in cantilever fashion...The potting material is in contact with the printed wire board and provides mechanical support for the printed wire board in the housing away from the heat sink."

Specifically, Claims 2, 4, 6 - 10, 13 and 14 depend directly from independent Claim 1. Specifically, Claim 1 recites a motor endshield assembly comprising "an endshield comprising an outer surface and an inner surface", "a control assembly in contact with said inner surface; and a power assembly connected to said control assembly." No such endshield assembly is taught or suggested by the cited combination. For at least the reasons set forth above with respect to the patentability of independent Claim 1, when the recitations of dependent Claims 2, 4, 6 - 10, 13 and 14 are considered in combination with the recitations of independent Claim 1, Applicants respectfully submit that Claims 2, 4, 6 - 10, 13 and 14 likewise meet the criteria for inventive step over Harms et al in view of Johnson et al.

Independent Claim 16 recites a motor endshield for an electronically commutated motor comprising “a shaft opening”, “an internal surface comprising a substantially flat raised area, and an external surface” with multiple raised fins and a raised portion surrounding the shaft opening.

Harms et al. in view of Johnson et al. do not teach nor suggest a motor endshield for an electronically commutated motor as described in Claim 16. Rather Harms et al. in view of Johnson et al. suggest mounted electronics in an enclosure, external to a motor, where the electronics mounted to a heat sink provide support for one side of a printed wire board and addition of potting material to the enclosure to provide support for the rest of the printed wire board. Applicants respectfully submit that Claim 16 meets the criteria for inventive step over Harms et al in view of Johnson et al.

Claims 17 and 19 depend directly from independent Claim 16. For at least the reasons set forth above with respect to the patentability of independent Claim 16, when the recitations of dependent Claims 17 and 19 are considered in combination with the recitations of independent Claim 16, Applicants respectfully submit that Claims 17 and 19 likewise meet the criteria for inventive step over Harms et al in view of Johnson et al.

Independent Claim 21 recites a method for assembling a motor endshield assembly for an electronically commutated motor, where the endshield assembly includes a control assembly, a power assembly and an endshield with an inner and outer surface. The method includes the steps of “positioning the control assembly in contact with the inner surface of the endshield and connecting the power assembly to the control assembly.

Harms et al. in view of Johnson et al. do not teach nor suggest a method of motor endshield assembly for an electronically commutated motor as described in Claim 21. Rather Harms et al. in view of Johnson et al. suggest a method of mounting electronics in an enclosure external to a motor, where the mounting of electronics to a heat sink provide support for one side of a printed wire board and adding potting material to the enclosure to provide support for the

rest of the printed wire board. Applicants respectfully submit that Claim 21 meets the criteria for inventive step over Harms et al in view of Johnson et al.

Claims 22 - 25 depend directly from independent Claim 21. For at least the reasons set forth above with respect to the patentability of independent Claim 21, when the recitations of dependent Claims 22 - 25 are considered in combination with the recitations of independent Claim 21, Applicants respectfully submit that Claims 22 - 25 likewise meet the criteria for inventive step over Harms et al in view of Johnson et al.

For the reasons set forth above, Applicants respectfully request that the statement that Claims 2, 4, 6 - 10, 13, 14, 16, 17, 19 and 21 - 25 lack inventive step under PCT Article 33(3) over Harms et al. in view of Johnson et al. be withdrawn.

The statement that Claims 18 and 20 lack inventive step under PCT Article 33(3) as being obvious over Harms et al. as modified by Johnson et al. is respectfully traversed.

Harms et al. describe an electronically commutated motor. More specifically, as described at Col. 9, lines 46 - 53, in Harms et al., the motor comprises "a flat faced end shield or adapter 73, having a plurality of rabbit-ear extensions 74 thereon is mounted to housing 71 at one opposite end thereof and a thermally conductive enclosure or enclosure means, such as a housing 75 or the like for instance, is arranged in mounting and enclosing association with the flat faced end shield thereby to enclose the housing at the one opposite end thereof."

Johnson et al describe the use of potting material to support the portion of a circuit board that is distant from the portion of the circuit board supported by attaching an electronic component(s) to a heat sink. More specifically, as described at Col. 1, lines 62 - 67 and Col. 2, lines 1 - 3, in Johnson et al., "(a) housing receiving and supporting the printed wire board and heat sink. The heat sink is mounted on the housing and the printed wire board is mounted on the heat sink and extends outwardly from the heat sink in cantilever fashion...The potting material is in contact with the printed wire board and provides mechanical support for the printed wire board in the housing away from the heat sink."

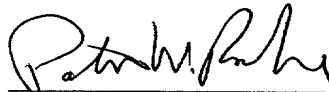
Specifically, Claims 18 and 20 depend directly from independent Claim 16. Specifically, Independent Claim 16 recites a motor endshield for an electronically commutated motor comprising "a shaft opening", "an internal surface comprising a substantially flat raised area, and an external surface" with multiple raised fins and a raised portion surrounding the shaft opening." No such endshield is taught or suggested by the cited combination. For at least the reasons set forth above with respect to the patentability of independent Claim 16, when the recitations of dependent Claims 18 and 20 are considered in combination with the recitations of independent Claim 16, Applicants respectfully submit that Claims 18 and 20 likewise meet the criteria for inventive step over Harms et al as modified by Johnson et al.

For the reasons set forth above, Applicants respectfully request that the statement that Claims 18 and 20 lack inventive step under PCT Article 33(3) over Harms et al. as modified by Johnson et al. be withdrawn.

The statement objecting to Claim 9 under PCT Article 66.2(a)(v) is respectfully traversed. Claim 9 has been amended to provide proper antecedent basis.

In view of the foregoing amendments and remarks, all the claims now active in this application are believed to meet the criteria for novelty, inventive step and industrial applicability under PCT Article 33(2)-(4). Favorable action is respectfully solicited.

Respectfully submitted,



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(314) 621-5070

CLAIMS:

1. A motor endshield assembly comprising:

an endshield comprising an outer surface and an inner surface, said outer surface including a plurality of fins;

a control assembly in contact with said inner surface; and

a power assembly connected to said control assembly.

2. A motor endshield assembly in accordance with Claim 1 wherein said inner surface further comprises a substantially flat raised area for contacting said control assembly.

3. A motor endshield assembly in accordance with Claim 1 wherein said control assembly comprises a control board and a plurality of power transistors connected to said control board.

4. A motor endshield assembly in accordance with Claim 3 wherein said control assembly further comprises a thermal pad between said power transistors and said endshield, said thermal pad for transferring heat from said transistors to said endshield and for electrically isolating said transistors.

5. A motor endshield assembly in accordance with Claim 1 wherein said endshield is configured as a heatsink.

6. A motor endshield assembly in accordance with Claim 3 wherein each said power transistor comprises a plurality of leads, each said lead extending substantially parallel to said control board.

7. A motor endshield assembly in accordance with Claim 6 wherein said transistors comprise a top surface, a bottom surface, a back, and a tab, said bottom

surface contacting said control board, said tab extending from said back along said top surface.

8. A motor endshield assembly in accordance with Claim 7 wherein said power transistor further includes a front, said leads extend from said front of said power transistors at a position closer to said bottom surface than to said top surface.

9. A motor endshield in accordance with Claim 8 wherein said tabs comprise metal, said tabs contact a thermal pad which provides a thermal interface to said endshield.

10. A motor endshield assembly in accordance with Claim 2 wherein said recessed fins extend from said substantially flat raised portion.

11. A motor endshield assembly in accordance with Claim 1 further comprising a cap plug opening extending through said endshield and a cap plug covering said cap plug opening.

12. A motor endshield assembly in accordance with Claim 1 wherein said endshield further comprises aluminum.

13. A motor endshield assembly in accordance with Claim 3 wherein said power assembly comprises a power board and an insulator positioned between said power board and said control board.

14. A motor endshield assembly in accordance with Claim 13 further comprising:

a first spacer extending between said control board and said power assembly;

a plurality of clamp bars positioned between said power assembly and said power transistors, said first spacer and said clamp bars extending through said insulator; and

a second spacer extending between said control board and said endshield.

15. A motor endshield assembly in accordance with Claim 1 wherein said endshield further comprises a plurality of bolt openings that extend through said endshield for receiving a through bolt.

5 16. A motor endshield for an electronically commutated motor, said endshield comprising:

a shaft opening configured to receive a motor shaft;

an internal surface comprising a substantially flat raised area; and

10 an external surface comprising a plurality of recessed fins and a raised cylindrical portion surrounding said opening.

17. A motor endshield in accordance with Claim 16 wherein said recessed fins extend from said substantially flat raised portion.

18. A motor endshield in accordance with Claim 16 further comprising a cap plug opening extending through said endshield.

15 19. A motor endshield in accordance with Claim 16 further comprising a plurality of recessed openings extending through said endshield, each said recessed opening for receiving a through bolt.

20. A motor endshield in accordance with Claim 16 wherein said endshield further comprises aluminum, said endshield configured as a heatsink.

20 21. A method of assembling a motor endshield assembly for an electronically commutated motor, the motor endshield assembly including a control assembly, a power assembly, and an endshield with an inner surface and an outer surface, said method comprising the steps of:

5/PRTS

09/806604
JC02 Rec'd PCT/PTO 02 APR 2001

MOTOR ENDSHIELD ASSEMBLY FOR AN ELECTRONICALLY COMMUTATED MOTOR

BACKGROUND OF THE INVENTION

This invention relates generally to electric motors and more particularly, to an endshield assembly for an electric motor.

Known electronically commutated motors have a multi-stage winding assembly and a magnetic assembly associated for relative rotation. The winding stages of the multi-stage winding assembly have a preset energization sequence that includes at least one unenergized winding stage in which an induced back EMF appears. When integrated over time to a predetermined value, the induced back EMF indicates the instant at which the relative angular position between the multi-stage winding assembly and the magnetic assembly is suitable for the sequential commutation of the next winding stage.

The electronic circuitry for an electronically commutated motor generally includes a power circuit, a regulating circuit, and a control circuit. The power circuit has solid state switching devices for commutating the power supplied to the electronically commutated motor to effect its energization. The regulating circuit has various solid state components for maintaining the power supplied to the electronically commutated motor generally constant. The control circuit has various solid state components for controlling the conductivity of the switching devices.

Some of the solid state components for an electronically commutated motor, e.g., transistors, need to be relatively large to accommodate the currents that must pass through them. Large transistors can produce a sizable amount of heat that should be dissipated from the transistors in order to keep them functioning properly. It is well known in the art that to promote heat dissipation, the electronic circuitry for an electronically commutated motor can be positioned adjacent an outer surface

of an endshield of the motor. However, this increases costs since another compartment is needed to protect the electronic circuitry.

Accordingly, it would be desirable to provide a mounting arrangement for the electronic components of an electronically commutated motor that provides good heat dissipation without significantly increasing the cost of the motor. Additionally, it would be desirable to eliminate the additional compartment needed to protect the electronic circuitry.

BRIEF SUMMARY OF THE INVENTION

Electronically commutated motors are well known, such as the motor described in U.S. Patent No. 5,006,744, which patent is assigned to the present assigned and hereby incorporated herein, in its entirety, by reference.

In an exemplary embodiment of the invention, a motor endshield assembly for an electronically commutated motor includes an endshield having an inner surface and an outer surface, with the outer surface including a plurality of recessed fins. The endshield assembly according to one embodiment of the present invention includes a control assembly and a power assembly mounted thereto. The control assembly includes a control board having a plurality of power transistors. The internal surface of the endshield includes a substantially flat raised area that is in contact with the control assembly and serves as a heatsink for the power transistors. The transistors are in contact with a thermal pad located between the transistors and the endshield. The thermal pad electrically insulates the transistors yet still conducts heat from the transistors to the endshield. The recessed fins are located directly above the substantially flat raised portion on the endshield and assist the dissipation of heat from the transistors and endshield to the ambient environment.

The power assembly includes a power board having an insulator positioned between the power board and the control board. A first spacer extends between the

control board and the power board to provide the proper spacing therebetween. A plurality of clamp bars are also positioned between the power board and the transistors. The clamp bars apply pressure to the transistors and keep the transistors in contact with the substantially flat raised portion of the endshield. The first spacer and the clamp bars extend through the insulator. A second spacer extends between the control board and the endshield to provide the proper spacing therebetween.

In one embodiment, each power transistor includes a plurality of leads that extend substantially parallel to the control board. The leads exit a front side of the transistor at a position that is closer to a bottom of the transistor than to a top. The bottom of the transistor is in contact with the control board while the top of the transistor includes a tab that extends from a back side of the transistor parallel to the control board.

With the above described endshield assembly, only one compartment is required since the electronic controls are located within the motor housing. In addition, use of the endshield as a low impedance path to dissipate heat from the power devices of the internal electronic circuitry to the ambient environment provides good thermal performance for the motor. Also, since the transistor leads are parallel to and away from the control board, the lengths of the leads are much closer to the surface of the board than in many known control assemblies. The leads are thus easy to encapsulate and protect from harsh external environments.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded view of an endshield assembly in accordance with one embodiment of the present invention;

Figure 2 is a perspective view of the endshield shown in Figure 1;

Figure 3 is a cross section of the endshield shown in Figure 2 along A-A;

Figure 4 is a schematic illustration of the thermal pad shown in Figure 1; and

Figure 5 is a schematic illustration of the insulator shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is an exploded view of an endshield assembly 100 for an electronically commutated motor (not shown). Endshield assembly 100 includes an endshield 102, a control assembly 104, and a power assembly 106. Control assembly 102 includes a control board 108, a plurality of transistors 110, a thermal pad 112, and a spacer 114. In one embodiment, spacer 114 is fabricated from nylon and extends between control board 108 and endshield 102. Spacer 114 helps to maintain a predetermined separation distance between control board 108 and endshield 102.

Transistors 110 include a front 116, back 118, top 120, bottom 122, and a tab 124. Tab 124 extends from back 118 of transistors 110 and has a surface 126 that is an extension of, and is substantially parallel to, top 120. A plurality of leads 128 extend from front 116 of transistor 110. In one embodiment, leads 128 extend substantially parallel to control board 108 and maintain a substantially constant separation distance between themselves and control board 108. Since leads 128 extend from front 116 in a location that is closer to control board 108 than to top 120, leads 128 remain relatively close to control board 108 throughout their length. Only a small separation distance exists between leads 128 and control board 108. The small separation distance allows conformal coating to easily encapsulate leads 128 which helps to protect them from damage in harsh environments. The encapsulation of leads 128 facilitates reducing failures caused by moisture in the area of high potential. To insert leads 128 into control board 108, leads 128 must be formed at right angles to transistor 110.

Transistors 110 are capable of producing significant heat depending on the amount of current that flows through them. The heat should be dissipated from the transistors and the surrounding motor in order to ensure proper operation of the motor. In one embodiment, top 120 of each transistor 110 is in thermal contact with thermal pad 112. Thermal pad 112 electrically isolates transistors 110 and conducts the heat generated by transistors 110 away from transistors 110. Thermal pad 112 contacts endshield 102 which includes an inner surface (not shown) and an outer surface 130 that has a plurality of recessed fins 132. In one embodiment, endshield 102 is fabricated from cast aluminum and serves a heatsink for transistors 110. The inner surface of endshield 102 includes a substantially flat raised portion (not shown). The substantially flat raised portion is in thermal contact with thermal pad 112 and is located directly beneath recessed fins 132. In one embodiment, recessed fins 132 extend from the substantially flat raised portion. The heat from transistors 110 travels through thermal pad 112 to endshield 102 and is dissipated from recessed fins 132 to the ambient environment. Endshield 102 serves as a heat sink to transistors 110 and helps to dissipate heat from transistors 110 to the ambient environment. This heat dissipation helps reduce stress on transistors 110. Endshield 102 further includes a cap plug opening 134 and a cap plug 136 as will be discussed in more detail below.

Power assembly 106 includes a power board 138, electronic components 140, a spacer 142, a plurality of clamp bars 144, and an insulator 146. Insulator 146 is positioned between control board 108 and power board 138 and electrically insulates portions of control board 108 from portions of power board 138. Spacer 142 and clamp bars 144 extend between control board 108 and power board 138. Spacer 142 and clamp bars 144 facilitate maintaining a predetermined distance between power board 142 and control board 108. Spacer 142 and clamp bars 144 extend through insulator 146 and are in contact with both control board 108 and power board 138. In one embodiment, spacer 142 is fabricated from nylon.

Clamp bars 144 are positioned on an opposite side of power board 138 from electronic components 140 and are located between electronic components 140 and transistors 110. Clamp bars 144 apply pressure on transistors 110 to ensure a good thermal interface between transistors 110 and endshield 102.

5 Figure 2 is a perspective view of endshield 102. Endshield 102 includes a shaft opening 148 for a rotor bearing (not shown). In one embodiment, outer surface 130 of endshield 102 includes a raised cylinder 150 that projects from endshield 102 and surrounds opening 148. Raised cylinder 150 includes a resilient ring (not shown) mounted therein. Endshield 102 further includes a plurality of bolt openings 152. Bolt openings 152 extend through endshield 102 and through bolts (not shown) are inserted therethrough to mount endshield 102 to the shell of an electronically commutated motor (not shown). Cap plug opening 134, as explained above, extends through endshield 102 and allows access to internal components (not shown) during final testing and calibration. Cap plug opening 134 permits access to the internal components without having to remove endshield 102. Cap plug 136 (not shown in Figure 2) covers cap plug opening 134 to protect the internal components.

15
20 Figure 3 is a cross-section view of endshield 102 and illustrates an inner surface 154 that includes a substantially flat raised portion 156. Raised portion 156 is located directly beneath recessed fins 132 and is a component of a thermal pathway between transistors 110 (not shown in Figure 3) and recessed fins 132. Recessed fins 132 extend from raised portion 154 to increase the surface area of outer surface 130 which facilitates the dissipation of heat from endshield 102. Raised cylinder 150 and bolt opening 152 are also illustrated in Figure 3.

25 Figure 4 is a schematic illustration of thermal pad 112. In one embodiment, thermal pad 112 includes angled sides to permit increased contact with a portion of

endshield 102 (not shown in Figure 4). Thermal pad 112 has two openings 158 to help secure thermal pad 112 to the endshield.

Figure 5 is a schematic illustration of insulator 146. Insulator 146 includes two openings 160 through which clamp bars 144 (not shown in Figure 5) extend. Openings 160 are generally rectangular in shape and are positioned in close proximity to each other. Insulator 146 also includes a shaft opening 162 through which a shaft (not shown) of the electronically commutated motor extends. Insulator 146 is fabricated from mylar and provides both thermal and electrical insulation. Insulator 146 also includes a spacer opening 164 through which spacer 142 (not shown in Figure 5) extends.

Endshield assembly 100 includes a thermal pathway that allows heat to be dissipated from the interior of endshield assembly 100, to the ambient environment. This thermal pathway enables control assembly 104 and power assembly 106 to be placed within the interior of the electronically commutated motor housing. This interior placement eliminates the need for a separate compartment to house the electronic controls of the motor, and facilitates reducing fabrication costs of the motor. In addition, the orientation of the transistor leads enables the leads to be encapsulated and protected from potentially harsh environmental conditions.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

Claims:

1. A motor endshield assembly comprising:

an endshield comprising an outer surface and an inner surface, said outer surface including a plurality of fins;

a control assembly in contact with said inner surface; and

a power assembly connected to said control assembly.

2. A motor endshield assembly in accordance with Claim 1 wherein said inner surface further comprises a substantially flat raised area for contacting said control assembly.

3. A motor endshield assembly in accordance with Claim 1 wherein said control assembly comprises a control board and a plurality of power transistors connected to said control board.

4. A motor endshield assembly in accordance with Claim 1 wherein said control assembly further comprises a thermal pad placed between said power transistors and said endshield, said thermal pad for transferring heat from said transistors to said endshield and for electrically isolating said transistors.

5. A motor endshield assembly in accordance with Claim 1 wherein said endshield is configured as a heatsink.

6. A motor endshield assembly in accordance with Claim 3 wherein each said power transistor comprises a plurality of leads, each said lead extending substantially parallel to said control board.

7. A motor endshield assembly in accordance with Claim 6 wherein said transistors comprise a top surface, a bottom surface, a front, a back, and a tab, said

bottom surface contacting said control board, said tab extending from said back along said top surface.

8. A motor endshield assembly in accordance with Claim 7 wherein said power transistor leads extend from said front of said power transistors at a position that is closer to said bottom surface than to said top surface.

9. A motor endshield in accordance with Claim 8 wherein said tabs comprise metal, said tabs contact said thermal pad which provides a thermal interface to said endshield.

10. A motor endshield assembly in accordance with Claim 2 wherein said recessed fins extend from said substantially flat raised portion.

11. A motor endshield assembly in accordance with Claim 1 further comprising a cap plug opening extending through said endshield and a cap plug covering said cap plug opening.

12. A motor endshield assembly in accordance with Claim 1 wherein said endshield further comprises aluminum.

13. A motor endshield assembly in accordance with Claim 3 wherein said power assembly comprises a power board and an insulator positioned between said power board and said control board.

14. A motor endshield assembly in accordance with Claim 13 further comprising:

a first spacer extending between said control board and said power assembly;

a plurality of clamp bars positioned between said power assembly and said power transistors, said first spacer and said clamp bars extending through said insulator; and

a second spacer extending between said control board and said endshield.

15. A motor endshield assembly in accordance with Claim 1 wherein said endshield further comprises a plurality of bolt openings that extend through said endshield for receiving a through bolt.

5 16. A motor endshield for an electronically commutated motor, said endshield comprising:

an internal surface comprising a substantially flat raised area;

an external surface comprising a plurality of recessed fins and a raised cylindrical portion surrounding said opening; and

10 a shaft opening configured to receive a motor shaft.

17. A motor endshield in accordance with Claim 16 wherein said recessed fins extend from said substantially flat raised portion.

18. A motor endshield in accordance with Claim 16 further comprising a cap plug opening extending through said endshield.

15 19. A motor endshield in accordance with Claim 16 further comprising a plurality of recessed openings extending through said endshield, each said recessed opening for receiving a through bolt.

20. A motor endshield in accordance with Claim 16 wherein said endshield further comprises aluminum, said endshield configured as a heatsink.

20 21. A method of assembling a motor endshield assembly for an electronically commutated motor, the motor endshield assembly including a control assembly, a power assembly, and an endshield with an inner surface and an outer surface, said method comprising the steps of:

positioning the control assembly in contact with the inner surface of the endshield; and

connecting the power assembly to the control assembly.

22. A method in accordance with Claim 21 wherein the control assembly includes a thermal pad and a control board with power transistors connected thereto, said step of positioning further comprising the steps of:

positioning the power transistors in thermal contact with the thermal pad; and

placing the thermal pad in contact with the endshield.

23. A method in accordance with Claim 22 wherein the endshield inner surface includes a substantially flat raised portion, and the endshield outer surface includes a plurality of recessed fins, the recessed fins extending from the raised portion, said method of placing the thermal pad comprising the step of placing the thermal pad in contact with the substantially flat raised portion of the endshield such that the power transistors are in thermal contact with the recessed fins, wherein a thermal pathway is provided to dissipate heat from the transistors to the recessed fins and then to the ambient environment.

24. A method in accordance with Claim 23 wherein the power assembly includes an insulator, a plurality of clamp bars, a spacer, and a power board, and wherein said step of connecting the power assembly to the control assembly comprises the step of placing the power assembly in contact with the control board.

25. A method in accordance with Claim 24 wherein said method further includes the step of positioning the clamp bars to apply pressure to the transistors to enhance the thermal contact between the transistors and the recessed fins of the endshield.

MOTOR ENDSHIELD ASSEMBLY FOR AN
ELECTRONICALLY COMMUTATED MOTOR

ABSTRACT OF THE DISCLOSURE

An endshield assembly for an electronically commutated motor includes an endshield, a control assembly, and a power assembly. The endshield includes a plurality of recessed fins on an outer surface, and a substantially flat raised portion on an internal surface. The raised portion is in contact with a thermal pad. The control assembly includes the thermal pad and a control board on which is located a plurality of power transistors. The thermal pad provides thermal contact between the transistors and the endshield to enable the endshield to dissipate heat from the transistors. The transistors include a plurality of leads that extend substantially parallel to the control board which enable the leads to be coated for protection against harsh external environments. The power assembly includes a power board having an insulator positioned between the power board and the control board.

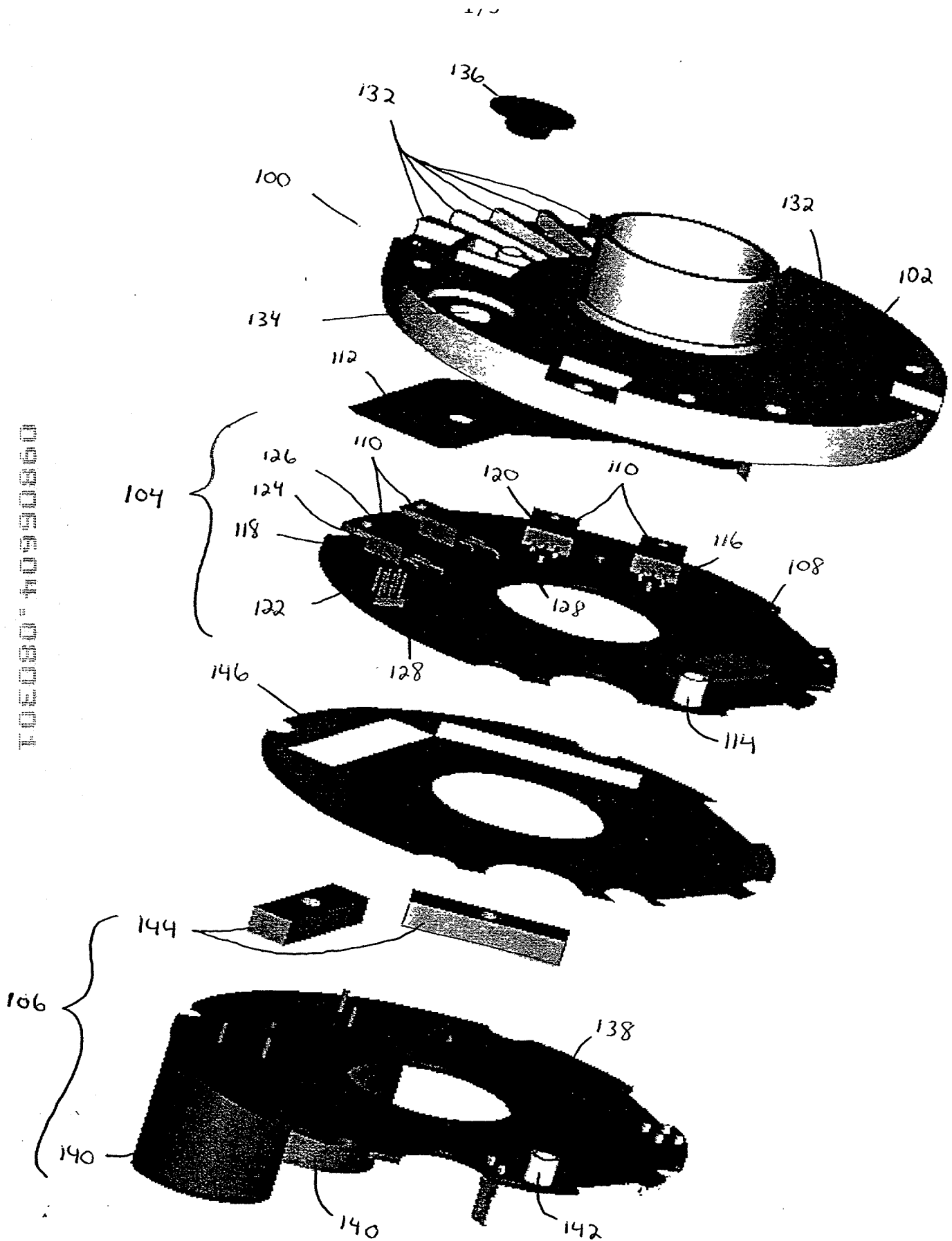


Figure 1

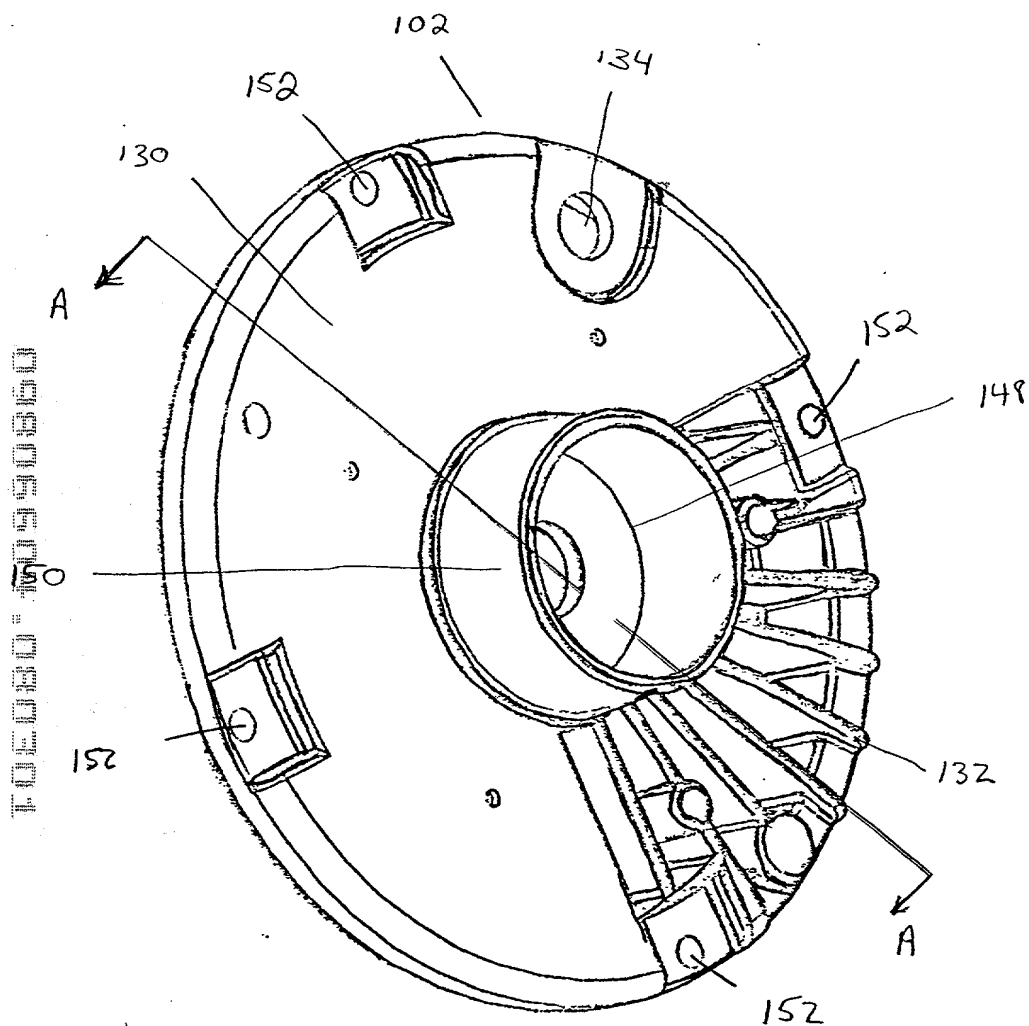


Figure 2

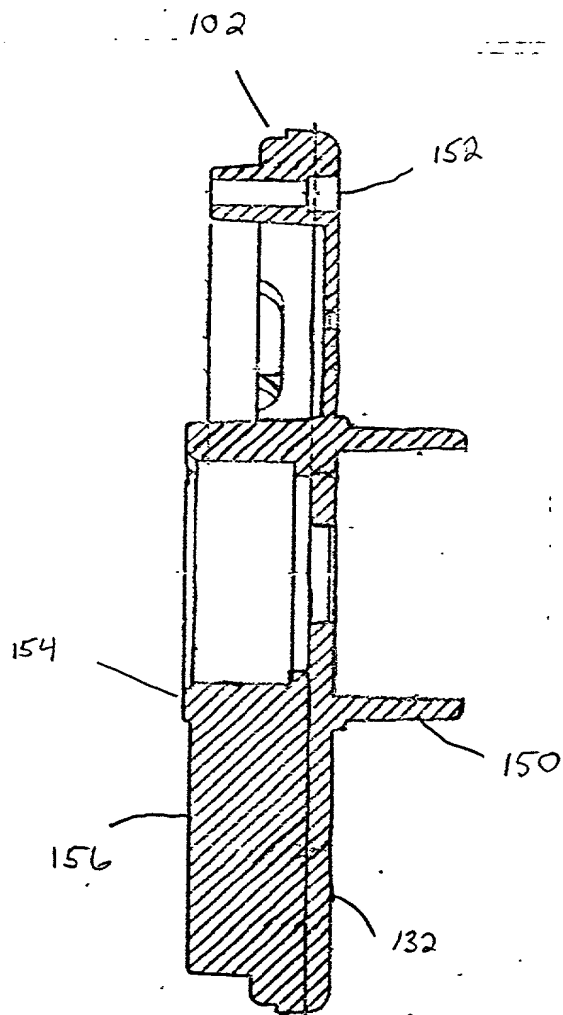


Figure 3

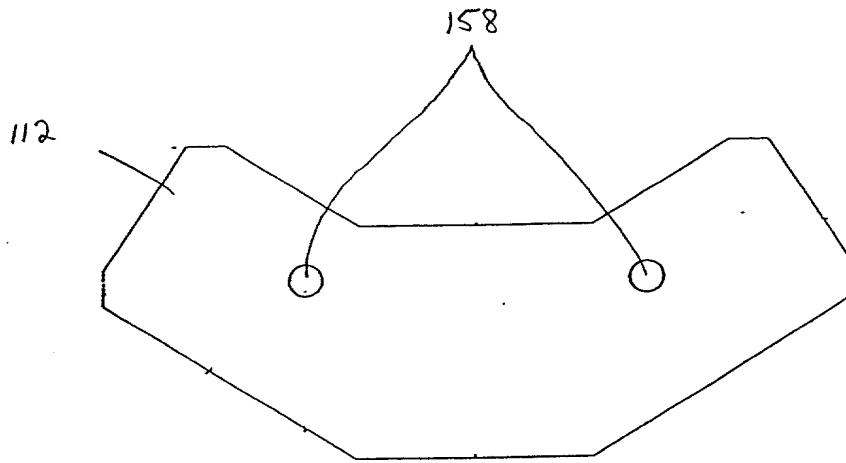


Figure 4

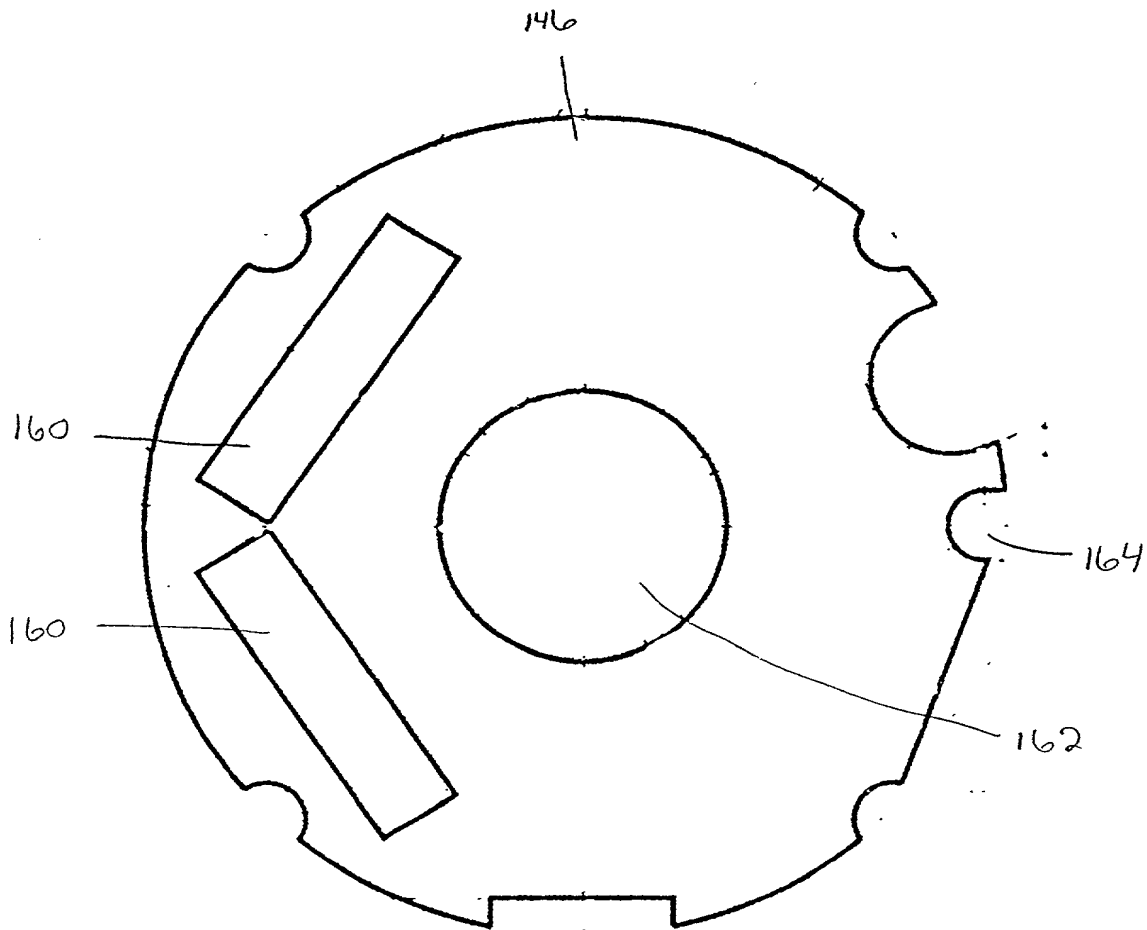


Figure 5

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **MOTOR ENDSHIELD ASSEMBLY FOR AN ELECTRONICALLY COMMUTATED MOTOR (Dkt. No. 03-LO-6740)** the specification of which:

(check one)

☐ is attached hereto

☒ was filed on June 30, 1998 as Application Serial No. 60/091,257 and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim priority benefits under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112. I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

PCT/US99/14753

29 JUN 1999

pending

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below:

Application Serial No.

Filing Date

Additional provisional application

60/091,257

June 30, 1998

numbers are listed on a

supplemental

priority sheet attached hereto.

I hereby appoint: Ronald E. Myrick (Reg. No. 26,315), General Electric Company, 3135 Easton Turnpike, Fairfield, CT 06431; Henry J. Policinski, Reg. No. 26,621, General Electric Company, 3135 Easton Turnpike, Fairfield, CT 06431; Edmund P. Anderson, Reg. No. 34,764, General Electric Company, 41 Woodford Avenue, Plainville, CT 06062; Carl B. Horton, Reg. No. 34,622, General Electric Company, 41 Woodford Avenue, Plainville, CT 06062; Wayne O. Traynham, Reg. No. 29,872, General Electric Company, 6465 East Johns Crossing, Duluth, GA 30097; John S. Beulick, Reg. No. 33,338, Armstrong Teasdale LLP, One Metropolitan Square, Suite 2600, St. Louis, MO 63102, jointly, and each of them severally, my attorneys and attorney, with full power of substitution, delegation and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent and to transact all business in the Patent and Trademark Office connected therewith.

I hereby direct that all correspondence and telephone calls in connection with this application be addressed to the said

John S. Beulick, Reg. No. 33,338
Armstrong Teasdale LLP
One Metropolitan Square, Suite 2600
St. Louis, MO 63102

Telephone No. (314) 621-5070.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application and any patent issued thereon.

SOLE OR FIRST INVENTOR:

Full Name: Kamron M. Wright

Signature: Kamron M. Wright

Date: 07/30/2001

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Citizenship: U.S.A.

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SECOND JOINT INVENTOR, IF ANY:

Full Name: Peter B. Lytle

Signature: _____

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Citizenship: U.S.A.

Post Office Address: 7711 Weymouth Court, Fort Wayne, IN 46825

THIRD JOINT INVENTOR, IF ANY:

Full Name: Andrew N. Young

Signature: _____

Date: _____

Residence: Roanoke, VA 24018

Citizenship: U.S.A.

Post Office Address: 5733 Spring Meadow Drive, Roanoke, VA 24018

Variable	Mean	Standard deviation	Minimum	Maximum
Age	34.5	10.5	20	55
Gender	0.5	0.5	0	1
Marital status	0.5	0.5	0	1
Education	12.5	1.5	10	15
Income	1.5	0.5	1	2
Health	1.5	0.5	1	2
Religion	0.5	0.5	0	1
Occupation	1.5	0.5	1	2
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State	1.5	0.5	1	2
Country	1.5	0.5	1	2
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Religion	0.5	0.5	0	1
Occupation	1.5	0.5	1	2
City	1.5	0.5	1	2

My residence, post office address and citizenship are as stated below next to my name.

(check one)

[] is attached hereto

[✓] was filed on June 30, 1998 as Application Serial No. 60/091,257 and
was amended on _____.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

PCT/US99/14753
(Application Serial No.)

29 JUN 1999
(Filing Date)

pending
(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

Application Serial No.
60/091,257

Filing Date
June 30, 1998

Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

1 of 2

I hereby direct that all correspondence and telephone calls in connection with this application be addressed to the said

John S. Beulick, Reg. No. 33,338
Armstrong Teasdale LLP
One Metropolitan Square, Suite 2600
St. Louis, MO 63102

Telephone No. (314) 621-5070.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application and any patent issued thereon.

SOLE OR FIRST INVENTOR:

Full Name: Kamron M. Wright

Signature: _____ Date: _____

Residence: Fort Wayne, IN 46819

Citizenship: U.S.A.

Post Office Address: 9612 Sea Pines, Fort Wayne, IN 46819

SECOND JOINT INVENTOR, IF ANY:

Full Name: Peter B. Lytle

Signature: Peter B. Lytle Date: 7-30-01

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Citizenship: U.S.A.

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THIRD JOINT INVENTOR, IF ANY:

Full Name: Andrew N. Young

Signature: _____ Date: _____

Residence: Roanoke, VA 24018

Citizenship: U.S.A.

Post Office Address: 5733 Spring Meadow Drive, Roanoke, VA 24018

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **MOTOR ENDSHIELD ASSEMBLY FOR AN ELECTRONICALLY COMMUTATED MOTOR (Dkt. No. 03-LO-6740)** the specification of which:

(check one)

☐ is attached hereto

☒ was filed on June 30, 1998 as Application Serial No. 60/091,257 and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

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(Filing Date)

(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

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PCT/US99/14753
(Application Serial No.)

29 JUN 1999
(Filing Date)

pending
(Status: patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

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60/091,257

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numbers are listed on a
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Signature: _____ Date: _____

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THIRD JOINT INVENTOR, IF ANY:

Full Name: Andrew N. Young *3-01*

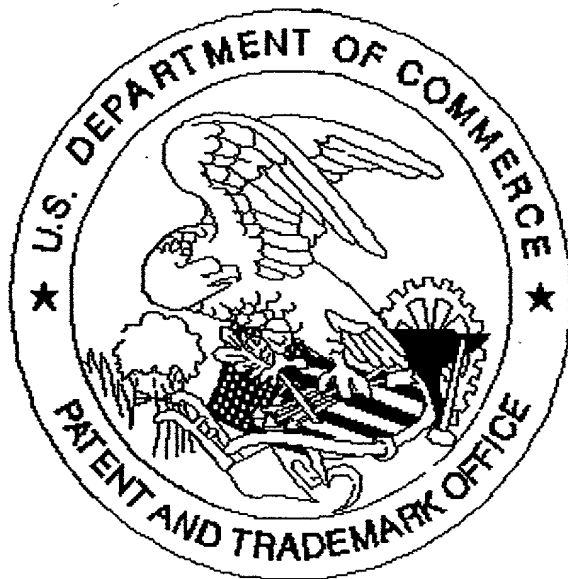
Signature: *Andrew N. Young* Date: 7/30/01

Residence: Roanoke, VA 24018

Citizenship: U.S.A. *VA*

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